Trice Interlock Controls

User Guide

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I. Introduction

The Trice Interlock Control System is designed to protect both personnel and equipment. The concern for personnel protection is due to having front-end electronics and power supplies powered by 120V, 60 Hz line power in an outdoor environment that potentially could be exposed to rain or moisture. To mitigate this concern, the interlock system has four highly-sensitive moisture sensors mounted on the top of the telescope. In the event of the detection of moisture, the interlock system shuts off the power to the front-end electronics from inside the trailer. Note that this power is provided by Ground-Fault Current Interrupters (GFCI), which will open the circuit breaker is there is a short circuit in the power supplies. Note also that the relay rack containing the power supplies is grounded locally to help reduce the risk of shock. The moisture sensors are designed to pre-empt any safety concerns that could occur due to rain, fog, or dew. Normally the telescope would not be operated in these conditions anyway, but the moisture sensors provide a measure additional safety margin built into hardware.

Equipment protection concerns protecting the photo-multiplier tubes in the camera of the telescope. These devices normally point upward, and can be damaged by either moisture or light. The protection consists of two sensor systems. In addition to shutting off the power supplies for the front-end electronics, the moisture sensors also shut off the high voltage power supply that powers the photo-multiplier tubes. The second sensor system incorporates highly-sensitive light sensors designed to detect high-level light bursts, car headlights, overhead airplanes, and the rising moon. Light from these sources can damage the tubes if the light is sustained. The interlock system is designed to quickly shut off the high voltage under these conditions. The light sensors are configured in four boxes mounted on the top four corners of the telescope (the same box that hosts the moisture sensors.) Each box has 3 light sensors, as will be described.

The system consists of the following components:

1. There are 4 sensor boxes on the top of the telescope. Each has 3 light sensors and 1 moisture sensor. The three light sensors are numbered 1, 2, and 3, corresponding to positions in the sensor box as top, front, and side respectively. Sensor 4 is the moisture sensor. The four sensor boxes are numbered 1 through four, corresponding to the four corners of the telescope: northwest, southwest, southeast, and northeast, respectively. The boxes are configured so that every direction has both a front light sensor and a side light sensor. There are a total of 4 sensors that are pointed up. Each sensor has it's own programmable DAC and a comparator to detect when a sensor has gone over threshold.

2. The Interlock Control Box resides in a relay rack in the trailer. It receives the comparator signals from the sensor boxes. It also is the means of writing threshold DAC values to the sensor boxes. When a fault occurs, the condition is evaluated by the Control Box, and a signal sent from the box to the Power Control

Units, which are separate units that control the power to the high voltage system and the front-end electronics. The front panel of the Control Box has LED indicators on the front panel to inform the user as to the states of the sensors. The front panel also has a toggle switch for resetting and arming the interlock system, and a switch for silencing the audio alarm. Finally, the box has one of the five crash buttons on the front panel for use as an emergency shut-off for the system. Note that the many functions in the system are not accessible from the Control Box. The Control Box is described in Section IV. Control of the system is described in Section VI. One other feature that the Control Box has is resident non-volatile memory for saving the current enables and DAC settings of all the sensors. This feature automatically loads the last values upon power-up, reducing the need for user intervention is restoring operating conditions each evening.

3. The Power Units reside in the relay rack in the trailer. They handle the actual switching of AC power between the outlets on the wall of the trailer, and the loads. There are three: Power Unit 1 controls the high-voltage power supply used to power the photomultiplier tubes. Power Unit 2 and Power Unit 3 control the power supplies for the MINDER Crate that resides under the telescope. The Interlock Control Box handles the control of these units differently, and assumes this convention. The loads should not be interchanged. The procedure for connecting them to the loads and the outlets on the wall is described in Section II.

4. The Interface Computer is the means by which settings in the system are changed. The computer also has the capability to read the current states of the sensors and display them on the screen. It also has a routine that can perform a calibration to accommodate the nightly ambient light conditions. The program also can save and recall settings in files, and perform data logging. These features are described in Section VI. The intention with the interlock system is to obtain settings for worst-case operating conditions, to program them into the system, and to run with these settings every night. The computer interface is provided for the case where greater control is desired to accommodate nightly changes in the ambient light conditions. It also is used to disable bad sensors that might occur in time. Mostly, the Control Box should be capable of functioning autonomously once set up, requiring only resetting of fault conditions that may occur. Nonetheless, the computer interface is relatively easy to use, and can be used nightly if the operational conditions require it.

II. Initial System Check

Before powering on Interlock Control Box and Power Control Units 1-3, check the following:

A. Begin with all power off in the system: the red power switch on the Interlock Control Box should be OFF, and the white breaker switch bars on the three Power Control Units should be OFF (in the DOWN position so that "0 0 0" is showing.) The power switch for the high voltage power supply should be off on the front of the power supply. It is recommended that the 6 power supplies for the MINDER Crate be OFF initially. These switches are located on the front of the MINDER Crate rack. The power supplies are OFF when the rocker switches are in the DOWN position.

B. Check that high voltage power supply line cord is plugged into outlet on back of Power Control Unit 1, in rear of rack containing MASTER Crate in the trailer.

C. Check that yellow line cord for MINDER power is plugged into outlet on back of Power Control Unit 2, in rear of rack containing MASTER Crate in the trailer.

D. Check that orange/black line cord for MINDER power is plugged into outlet on back of Power Control Unit 3, in rear of rack containing MASTER Crate in the trailer.

E. Check that line cord for Power Control Unit 1 is plugged securely into CKT 7 outlet on wall behind racks in the trailer.

F. Check that line cord for Power Control Unit 2 is plugged securely into CKT 11 outlet on wall behind racks in the trailer. This is a GFCI-protected circuit (Ground-Fault Current Interrupt), and is used for powering half of the power supplies used outside by the MINDER Crate.

G. Check that line cord for Power Control Unit 3 is plugged securely into CKT 9 outlet on wall behind racks in the trailer. This is also a GFCI-protected circuit, used for powering the other half of the power supplies for the MINDER Crate.

H. Make sure that the grey control cables that connect between the back of the Interlock Control Box the Power Control Units are firmly plugged in on both ends.

I. Make sure that the small toggle switch located on the front of the Power Control Units are in the "Remote On" position. These are 3-position switches, and are easily bumped. The correct position is all the way to the left.

III. Powering Up the Interlock System

It's best to begin configuring the Interlock Control System when the conditions are dark, and before the tent is removed from the telescope. The light sensors are very sensitive, and will trip when there is daylight even when the tent is in place over the telescope.

A. Turn on the Trice Interlock Computer by pushing the power button on the front of the computer. The computer is configured to boot up into the control program. Initially all of the sensors will be in the trip state. That's OK.

B. Turn on the red power switch on front panel of Interlock Control Box, located above MASTER Crate. For the first few seconds, the "Lock Out" LED on the front panel of the Interlock Control Box will stay lit. During this time, the control unit is going through an internal configuration process, and the controls are inactive.

C. After the Interlock Control Box is turned on, it will take approximately ½ hour for the sensors to reach equilibrium. It is recommended to wait for the system to reach equilibrium before proceeding.

E. Turn on the white breaker switches on the back of the Power Control Units 1-3 by moving the white bar into the UP position so that "1 1 1" is showing.

C. The power to the MINDER Crate may now be turned on. This is done by turning on the switches on the front of the MINDER Crate rack, generally by pushing the rocker switches into the UP position. While the order is not absolutely critical, it is a good idea to turn the switches on from the bottom first, going up the line, doing the top supply last. Power should be applied to the MINDER Crate. Note that if any of the sensors are tripped, the MINDER Crate power supplies will not come on. If this occurs, that's OK at this point. Turn the supplies on and proceed to Section IV.

IV. Description of the LEDs on the Interlock Control Box

The front panel of the Interlock Control Box has a number of LEDs that indicate the current condition of the system. There are also several switches that provide the ability to reset/arm the system, and also to perform tests. Note that functions associated with changing DAC thresholds or enabling or disabling sensors cannot be done from the front panel of the Interlock Control Box. These functions can only be done using the computer that communicates with the box. This is described in Section V.

The following is a description of the LEDs on the front panel. Refer to Fig. 1.

Fig. 1. Front Panel of Interlock Control Box

A. The 3 green LEDs in a column on the left side of the front panel labeled, "+VDD", "-VSS", and "+5v" indicate the presence of low-voltage power used by the digital and analog electronics. They should all be lit when the control box is turned on.

B. The red LED in the lower left of the front panel labeled "LOCK OUT" is an indicator that the logic inside the control box is in being configured. This LED will light up for a few seconds when the power to the control box is first turned on. After the logic is configured, the LED will turn off, and should stay off for the remainder of the time that power is on.

C. The 3 green LEDs in a row in the lower left of the front panel labeled "POWER UNITS" indicate whether the control for the box is commanding the power relays to be on or off. POWER UNIT 1 is for the high voltage power supply. POWER UNIT 2 and POWER UNIT 3 are for the MINDER Crate power supplies. When these LEDs are lit, a DC level is sent to the respective Power Control Units to energize the relays, thereby energizing the respective loads. If any LED is not lit, then the corresponding power relay is not energized, and the load will not be energized. Power Units 2 and 3 operate together, either both on or both off.

The logic in the control box is configured to control fault conditions in a certain way. Power Control Unit 1 is reserved for the high voltage power supply for the photo-multiplier tubes in the camera head. The control signal for the associated power relay will be disabled whenever there is either a fault from a light sensor, or a fault from a moisture sensor, or if a crash button is pressed. Power Control Units 2 and 3 are reserved for the power supplies for the MINDER Crate. The control signals for the associated power relays will be disabled whenever there is either a fault from a moisture sensor, or if a crash button is pressed. NOTE THAT THE POWER TO THE MINDER POWER SUPPLIES IS NOT DISABLED IF THERE IS A FAULT FROM A LIGHT SOURCE.

D. There are 4 sensor boxes on the top of the telescope. Each has 3 light sensors and 1 moisture sensor. There is an array of red/yellow/green LEDs on the front panel of the control box. The nomenclature near the top edge of the front panel of the control box identifies the sensors grouped by box number. The leftmost group is sensor box 1, followed by sensor boxes 2, 3, and 4 in the rightmost side. The three light sensors are numbered 1, 2, and 3, corresponding to positions in the sensor box as top, front, and side respectively. Sensor 4 is the moisture sensor (marked "RAIN" on the front panel.) The four sensor boxes are numbered 1 through four, corresponding to the four corners of the telescope: northwest, southwest, southeast, and northeast, respectively. The boxes are configured so that every direction has both a front light sensor and a side light sensor. There are a total of 4 sensors that are pointed up.

E. The row of green 16 LEDs marked "ARM" (4 per sensor box, 4 sensor boxes) indicate which of the sensors are enabled. If a sensor is not enabled, it's signal will not be part of the interlock controls. Note that the only way to arm or disarm a sensor is through the computer. Note also that in the extreme case where none of the sensors are armed, then no sensor can create a fault condition, and the Interlock Control System is effectively bypassed.

F. The row of 16 red LEDs marked "TRIPPED" (4 per sensor box, 4 sensor boxes) indicate which of the sensors have tripped. In general, a sensor should not trip if it is not armed. The exception is at power-up when logic states are in flux. If a sensor trips at power-up when it is not armed, it should clear when the unit is reset (described below.) Note that when a sensor trips, this is a latched state, and can only be cleared through a reset command. Whenever one or more sensors are tripped, then one or more of the power control signals will be disabled. In general, all of the "Tripped" LEDs must be unlit to be able to arm the system.

G. The row of 16 yellow LEDs marked "FOLLOW" (4 per sensor box, 4 sensor boxes) are the real-time states of the comparators for each sensor. In general, if one of these LEDs is lit, the corresponding "Tripped" LED should also be lit. In this case, it will not be possible to clear the trip until the "Follow" LED is unlit.

This is an indication that either there is a fault condition (a light source or moisture on the moisture sensor), or that the threshold is set too low. This condition may also occur if there is a malfunction in one of the sensors. Note that disabling a sensor or changing a threshold can only be done using the computer. Note also that if a sensor trips due to a brief fault (such as a power flash of light), then the affected "Follow" LED will flash briefly, and the associated "Tripped" LED will light ad stay lit until the unit is reset.

H. There are 5 crash buttons in the system, one on the front panel of the control box, and 4 located on the vertical supports of the telescope. The buttons have a locking feature such that when pressed, they stay engaged. To disengage, the button must be turned clock-wise a short distance, which will then cause the button to be disengaged and spring back. There are 5 red LEDs in the upper right corner of the front panel of the control box marked "EMERGENCY STOP SWITCH", and just below the LEDs marked "AUX STOPS". The LEDs are lit whenever a crash button is pressed. The LED for Emergency Stop #1 is the crash button on the front panel of the control box. The LEDs for Emergency Stop #2 - #5 are for the crash buttons on the telescope. Note that once a crash button is pressed, the control signals to all three power control units are disabled. Note also that once a crash button is pressed, the crash state is latched, and two operations must be done to clear it: the crash button must be disengaged, and the control unit reset and then armed.

I. There are 4 red LEDs on the right side of the front panel of the control box that are unmarked. These have no function currently.

J. The toggle switch marked "ARM" above and "RESET below on the left side of the front panel of the control box perform the indicated functions. If a fault condition has caused the control box to trip, then either the fault must be removed, or the sensor threshold changed, or the sensor disabled in order to re-energize the instrumentation. Once the conditions that have caused the fault condition are removed, all of the "Follow" LEDs should be unlit. To enable the power relays then, first move the "Reset/Arm" toggle switch into the "Reset" (down) position. This should clear all of the "Tripped" states. Then, move the "Reset/Arm" toggle switch into the "Arm" (up) position. This should energize the power relays in the Power Control Units. A sign of success is when the 3 green "Power Unit" LEDs on the front panel of the control box light.

K. The push button on the front panel of the control box labeled "LIGHT TEST' causes an LED in each sensor box to light up. This is used to test that the light sensors are working. The strength of the light from the LEDs is controlled by the computer, and cannot be changed from the front panel of the control box. Note that the LEDs put out a large amount of light that saturate the light sensors. It may take several tens of seconds for the sensors to recover after the light pulse.

L. The control box has a feature that whenever a fault condition occurs, there is an audio alarm that goes off. This alarm can be silenced by pressing the “LED TEST/AUDIO TEST” into the “down” position.

V. Description of the Computer Interface Screen

The user interface of the computer control program resembles the front panel of the control box. Many of the LED states of the control box are read by the computer, and displayed real-time. These are described below:

A. The 3 digits in a row in the center of the screen on the left side labeled "POWER UNITS" indicate whether the control for the box is commanding the power relays to be on or off. They are synonymous with the corresponding LEDs on the front panel of the control box. The indicator for POWER UNIT 1 is for the high voltage power supply, and is in the left-most position. The indicators for POWER UNIT 2 and POWER UNIT 3 follow, and are for the MINDER Crate power supplies. A white "0" indicates that the corresponding power relay is not energized and the load is off. A green "1" indicates the Power Control Units have the relays energized and the load is on. These indicators are read continuously from the front panel of the control box.

B. Like the front panel of the control box, the enable and trip states of the sensors are displayed in the upper part of the computer screen. The leftmost group is sensor box 1, followed by sensor boxes 2, 3, and 4 in the rightmost side. The three light sensors are numbered 1, 2, and 3, and the moisture sensor is sensor 4. The indicators for the five Emergency Stop crash buttons are shown on the right side of the screen.

C. The row of 16 digits marked "Enable States:" (4 per sensor box, 4 sensor boxes) indicate which of the sensors are enabled. A white "0" indicates that the corresponding sensor is disabled, while a green "1" indicates that it is enabled. As before, if a sensor is not enabled, it's signal will not be part of the interlock controls. Note that the only way to arm or disarm a sensor is through the computer.

D. The row of 16 digits marked "Trip States:" (4 per sensor box, 4 sensor boxes) indicate which of the sensors have tripped. A white "0" indicates that the sensor has not tripped, while a red "1" indicates a tripped condition. Like the indicators on the front panel of the control box, the tripped states are latched, and can only be cleared through a reset command. Whenever one or more sensors are tripped, then one or more of the power control signals will be disabled.

E. The computer does not read the "FOLLOW" states that are shown on the front of the control box. These can only be observed on the control box.

F. The states of the 5 crash buttons in the system are displayed on the computer screen, under the heading, "Emer Stop". Whenever a crash button is pressed,

the corresponding digit will display a red “1”. When the buttons are released, the digit will display a white “0”.

G. The values of the DACs are displayed in a row across the center of the screen. Each sensor has a separate 8-bit DAC, and the values can range from 0 to 255, with 0 the most sensitive setting, and 255 the least sensitive setting. The values shown are the actual readback values. Refer to Section VI for the procedure on setting the DACs.

H. The system has the capability to produce a variable-intensity flash of an LED in each sensor box. The intensity is controlled by an 8-bit DAC, and the current setting is shown in the lower right part of the computer screen.

I. The control program has a series of nested menus for performing different functions. The menus are shown across the bottom of the computer screen. Selections are generally made by entering single characters from the keyboard, although certain commands must be made by entering numbers (such as setting DACs). The upper-most menu is labeled “Main Menu.” Pressing “E” from the Main Menu will exit the program. When in sub menus, return to the Main Menu by pressing “B” for “Back”. The current menu is displayed across the bottom of the screen.

VI. Controlling the Interlock Using the Computer Interface

The user interface of the computer control program resembles the front panel of the control box. Many of the LED states of the control box are read by the computer, and displayed real-time. In addition, all of the control features (enabling/disabling the sensors, setting DAC thresholds, resetting and arming the system, calibrations, etc.) are performed through this interface. These are described below:

A. Resetting the System

When the Main Menu is displayed, the control box can be reset by pressing the "R" key ("R-RST" on the Main Menu.) This is equivalent to pressing the "Reset/Arm" toggle switch on the front panel of the control box to the "Reset" position.

B. Arming the System

When the Main Menu is displayed, the control box can be armed by pressing the "A" key ("A-Arm" on the Main Menu.) This is equivalent to pressing the "Reset/Arm" toggle switch on the front panel of the control box to the "Arm" position.

C. Silencing the Alarm

When the Main Menu is displayed, the audio alarm in the control box can be silenced by pressing the "Q" key ("Q-Quiet" on the Main Menu.) This is active only if the audio alarm is currently active.

D. Enabling/Disabling Sensors

When the Main Menu is displayed, the routine for disabling or enabling sensors is accessed by pressing the "N" key ("N-Enbl" on the Main Menu.) Then, sensors can be either enabled or disabled.

1. Enabling ("Setting") Sensors

Press "S" ("S-Set" on the "Enable Sensor Setup Menu") to enable a sensor. To enable an individual sensor, first enter a sensor box number (1-4, followed by pushing the RET key), then entering a sensor number (1-4, followed by pushing the RET key). The enable command is then sent immediately, and both the computer screen and the front panel of the control box should be updated. The routine is a loop, and you can either repeat by

choosing another sensor to enable, or just press the RET key to leave the routine. Alternatively, you can enable all the sensors at once by pressing the "A" key ("A" for "All") at any point in the "Set" routine.

2. Disabling Sensors

   Press "D" ("D-Disable" on the "Enable Sensor Setup Menu") to disableable a sensor. Like the "Set" routine, disable an individual sensor by first entering a sensor box number (1-4, followed by pushing the RET key), then entering a sensor number (1-4, followed by pushing the RET key). The disable command is then sent immediately, and both the computer screen and the front panel of the control box should be updated. You can either repeat, or press the RET key to leave the routine. You can disable all the sensors at once by pressing the "A" key ("A" for "All") at any point in the "Disable" routine.

3. Reset, Arm, & Quiet

   The commands to reset (R), arm (A) and quiet the alarm (Q) work in the "Enable Sensor Setup Menu as well.

4. Restoring Original Values

   While in the "Enable Sensor Setup Menu", you can restore the values that existed prior to entering the routine by pressing the "O" key ("O" for "Original Values"). This does not work while in the "Set" or "Disable" subroutines.

5. Leaving the Enable Sensor Setup Submenu

   To leave the" Enable Sensor Setup Menu" and return to the "Main Menu"', press "B" ("B-Back").

E. Setting Threshold DACs Manually

When the Main Menu is displayed, the routine for setting threshold values is accessed by pressing the "D" key ("D-DAC" on the Main Menu.) .

1. Setting DACs

   Press "S" ("S-Set" on the "DAC Setup Menu") to set a DAC value. To set the DAC an individual sensor, first enter a sensor box number (1-4, followed by pushing the RET key), then entering a sensor number (1-4, followed by pushing the RET key). The program then prompts to enter a new DAC value, from 0 to 255. Low DAC values correspond to more

sensitive settings; high DAC values correspond to less sensitive settings. Note that a setting of 255, the maximum possible value, does not make the sensors insensitive to light or moisture. A sensor can only be made 100% insensitive to stimuli by disabling the sensor. Note also that entering too low of a DAC value may put the threshold setting in the "noise floor" of the discriminator where electronic noise dominates, rendering the sensor insensitive. In this case though, the sensor is usually in the tripped state. For proper operation, the light sensors should be calibrated, as described in Section VI, subsection xx.

Once the DAC value has been entered (followed by hitting RET), the command is then sent immediately, and the computer screen should be updated. The routine is a loop, and you can either repeat by choosing another sensor to enable, or just press the RET key to leave the routine. Alternatively, you can enable all the sensors at once by pressing the "A" key ("A" for "All") at any point in the "Set" routine.

Example values: On a very dark night, typical DAC values for the light sensors should be around 160. The sensors have slightly different offsets, but have approximately the same gain, so actual values may vary. On bright nights, the DAC values may be substantially higher, approaching 255, the maximum value. For the moisture sensors, the DAC values should be set around 50 for dry conditions, and approach full scale for humid conditions. Note that the moisture sensors may trip from fog or dew.

2. Applying an Offset to the Light Sensor Thresholds

   Press "O" ("O-Offset" on the "DAC Setup Menu") to add a global offset to the threshold values for all light sensors that are enabled. The light sensors have approximately the same sensitivity (gain), but may have different voltage offsets due to light conditions or internal offset voltages. This feature allows the sensitivity level to be changed globally either up or down. To decrease a threshold (sensors will then trip on lower light levels), enter a negative number. To increase a threshold (sensors trip on higher light levels), enter a positive number. The DACs go from 0 to 255, so if the resulting addition or subtraction exceeds these limits, the maximum or minimum value will be used.

3. Reset, Arm, & Quiet

   The commands to reset (R), arm (A) and quiet the alarm (Q) work in the "Enable Sensor Setup Menu as well.

4. Restoring Original Values

   While in the "DAC Setup Menu", you can restore the values that existed prior to entering the routine by pressing the "P" key ("P" for "Previous Values"). This does not work while in the "Set" or "Offset" subroutines.

5. Leaving the Enable Sensor Setup Submenu

   To leave the" Enable Sensor Setup Menu" and return to the "Main Menu"', press "B" ("B-Back").

F. Initializing the System – Passive State

When the Main Menu is displayed, the routine for initializing the control box is accessed by pressing the "I" key ("I-Init" on the Main Menu.). This puts the control box into a passive state, with all sensors disabled, and all DACs set to the maximum value (255). This is a way to passivate the unit so that the power control units are active but the sensors are not part of the control system. USE THIS WITH CAUTION, AS IT DEFEATS THE INTERLOCK CONTROLS. As a safeguard, you must enter "Y" to proceed. Entering any other key will abort the operation.

G. Test of System

When the Main Menu is displayed, the routine for testing the performance of the Interlock Control Box is accessed by pressing the "T" key ("T-Tst" on the Main Menu.). This feature is reserved for experts, and will not be described here.

H. Calibrate Sensors

This procedure is used to find the threshold DAC values corresponding to the ambient light levels for the light sensors. The routine operates only on those light sensors that are enabled prior to entering the routine. The routine does not operate on the moisture sensors, which are temporarily disabled for this routine, and does not operate on light sensors that are disabled prior to entering the routine..

The routine is accessed from the Main Menu by pressing the "C" key ("C-Cal" on the Main Menu.). You are then asked to enter a starting value for the DACs. In general, it is recommended to start at 255 unless it is known that the ambient light levels are low, in which case the user may "guess" an appropriate starting value. (The only reason to do this would be to save a little time.) The routine

begins at this DAC value, and checks to see if any sensors have tripped. If a sensor has tripped, the DAC value for that sensor is frozen, and that sensor temporarily disabled. (If the routine starts out with a sensor tripped, either the starting point was too low, or the ambient light levels are too high.) The routine then resets the control box, and decreases all remaining DACs by one count (making the sensors more sensitive), and repeating the procedure until either all sensors have tripped, or the DAC value reaches 0.

When the routine has completed, the previous settings of the enables for the light sensors are restored, and the threshold values left at the values found corresponding to the ambient light levels for each sensor. Note that the values may be quite different. This is due to differences in ambient light seen looking in the different directions, as well as internal offset voltages that are not controlled. When the DACs are set corresponding to ambient light, many of the sensors may go into the tripped state.

In general, you will not operate the DACs at these thresholds, but instead add a positive offset to get away from the "ambient light floor." (At this writing, experience with the system will be needed to judge the appropriate offset above the ambient light floor. Initial tests suggested that a value of ~30 DAC counts is sufficient.) After the CAL procedure has completed, an offset can be applied by pressing the "O" key ("O-Apply Offset".) Negative values are not allowed here, and any offset added that would result in a value greater than 255 is limited to 255. At this point in the routine, the user may reset the unit by pressing the "R" key ("R-Reset Unit"), or repeat the calibration run by pressing the "G" key ("G-Go Again"), or exit the routine by pressing the "B" key ("B-Back").

When leaving the routine, the user is prompted as to whether the DAC values currently displayed on the screen should be kept or not. Prior to starting the routine, the program reads all DAC values and stores them away. If the calibration run has been messed up for some reason, .these values can be restored. Once exiting the calibration routine, the old values are lost unless they have been saved in a file beforehand. (See Subsection J below.)

I Enable Event Logging.

When the Main Menu is displayed, the routine for enabling event logging is accessed by pressing the "L" key ("L-Log" on the Main Menu.) This routine logs to a file all events that occur, including initial settings, trips, reset, etc. It is recommended that this feature be used during the operation of the telescope so that events or system problems can be tracked. Once initiated, the logging can be halted by hitting any key.

J. Saving/Recalling Settings in a File

When the Main Menu is displayed, the routine for saving and recalling setup files is accessed by pressing the “F” key (“F-File” on the Main Menu.). This feature saves all of the enable states, and all of the DAC values. There is a default directory for these files. Filenames must be 8 characters or less, and have the extension “.SET”. A useful scheme is to encode the date in msb numerical form: January 19, 2007 becomes “070119.SET”. It is a good idea to save the settings before doing a calibration, in case something goes wrong. It is also a good idea to save the settings before starting a data-taking run with the telescope.